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CROPPING NORTH OF [illegible].

Lantern Slide Address by W.D. Albright, Superintandent, Dominion Experimental Substation, Beaverlodge, Alberta, given before the Geographical Section of the American Association for the Advancement of Science Meeting in Ottawa, June 27, 1938.

It affords me great pleasure to address this international audience for while our thesis touches a note of ardent nationalism I trust it may also carry an international appeal.

Settled Canada has three fixed bounds and only one direction in which to expand. The southern boundary is about three thousand miles long. Three thousand miles multiplied by nothing equals nothing. Multiplied by 100 it equals 300,000 square miles; multiplied by 500, 1,500,000 square miles; multiplied by 1,000, 3,000,000 square miles. The future of Canada lies in its breadth. To every Canadian, anxious to see his country realize a great destiny, it becomes, then, a question of prime national importance how far north Canada may be proven habitable and good.

Race, language and tradition may preserve the identity of certain small European nations so long as they are not threatened by belligerent aggression but on this North American continent with its peaceful frontiers and its close association of related peoples speaking a common language the case is quite different. Had Canada remained as it was in my boyhood days, a narrow string of discontinuous settlements fronting a rich self-contained neighbour with a century's lead in natural development, the inevitable consequence would have been annexation. The Dominion would have been a mere appanage of the Republic--dependent in trade, in industry, in transportation, in thought, culture and outlook. Opportunity for genius would have continued to beckon chiefly from the populous centres to the south. The Northern country would have been persistently drained of its talent. Ultimately it would have been absorbed politically, as Goldwin Smith divined. Geography would have had its way.

It may do so still in time. Nationalism may give way to the concept of world federation and world citizenship. Perhaps in this, America should lead the way but I, for one, while warm in my admiration for the Republic whence most of my ancestors came, cordial in my friendship for its people and proud of the unfortified boundary which typifies our mutual trust and goodwill, am nevertheless imbued with a desire to see Canada work out her separate destiny on the northern half of this continent. She can do it only by developing a broad physical basis. Canada, like Russia, must look to the North. Her big, friendly southern neighbour, confident of her co-operation in all the high aims of civilization, will follow her progress with satisfaction.

For a particular reason of her own very proper concern the Republic must be interested in the Dominion's conquest of the North. In the modern surge of racial expansion, in the mad quest for economic self-sufficiency, in the race of armaments and in the unscrupulous scramble for "a place in the sun", which seems often to mean territorial expansion, is it to be supposed that the northern third of this continent can be held by the white man unless developed and utilized by him? What of Asia.

"Will the yellow man stand the climate?" is sometimes asked in illusory protest.

In 1930 I saw a Japanese family living at Fort McMurray, 534 miles north of the 49th parallel. At Fort Chipewyan, 671 miles north of the boundary, was a Chinese restaurant. The Mackenzie Valley still echoes the fame of Wada, the Japanese dog musher of the North. Only too well may the yellow race adapt itself, and surely it will do so, by peaceful penetration at first then by conquest, if the Caucasian neglects Nature's motto, "Use or lose."

The Dominion of Canada, the continent of America, the British Empire, the civilized world have a vital interest in the wise, systematic and successful utilization of Canada's Northern mines, forests and plains even to the Arctic littoral and the islands of the Arctic Archipelago. It is, therefore, no mere local problem of which I speak to you tonight. I might have styled it "the romance of our North frontier."

A Reconnaissance Flight Down the Mackenzie.

In 1930, after sixteen years' residence in the Peace River country at a point 429 miles north of the 49th parallel of latitude, it was my privilege as an agent of the Dominion Department of Agriculture, acting under instructions of Dr. E.S. Archibald, Director of Dominion Experimental Farms, to fly down the Mackenzie River system from Fort McMurray, Alta., to Herschel Island, Y.T., and back, circumnavigating Great Slave Lake on the return. This 4,015-mile flight was made in a plane of the Royal Canadian Air Force. During the three weeks expedition the leading settlements along the water route were visited and more than ninety interviews were obtained, 57 being with persons who had grown farm or garden crops from McMurray north. During the subsequent years, touch with the North has been maintained by correspondence and by regular study of official reports of the substations conducted by the Oblate Missions in co-operation with the Experimental Farms Branch. With the help of lantern slides I shall endeavour to depict a few salient facts thus gleaned.

Horses have ranged successfully along the Sixtieth Parallel of latitude. Crab apples have been repeatedly ripened in the open garden on the south shore of Great Slave Lake at a point 526 miles almost due north of Edmonton. At Fort Simpson, where the Liard joins the Mackenzie, 892 miles north of the United States, potato vines grew an inch and a half a day, doubling their height in a week. In two years out of ten tomatoes ripened in the garden, while winter eggs have been successfully produced there and at points much farther north. Vegetables and green-oat sheaves have been grown on the edge of the Thelon Game Sanctuary (the muskox preserve). Common wild fruits occur to Arctic tidewater. Potatoes, cabbages and other vegetables are regularly planted at points down the Mackenzie to its delta. Market gardening on a very limited scale has been actually done in the mining field on Great Bear Lake. A Swede at Oscar Creek, below Fort Norman, raised potatoes from seed balls he had gathered there. W.D. Clark, 80 miles beyond the Arctic Circle, has ripened tomatoes by coddling, achieved a pumpkin or two in 1932 and phenomenal crops of potatoes and vegetables in most years, also growing cereals for his chickens and declaring that a garden in that latitude was worth $500.00 a year to a man with a family. Potatoes and rhubarb have been raised with a modicum of success at Aklavik while cereals sufficiently mature to reproduce have twice been raised in the Mackenzie Delta at a point 1,317 miles north of the Forty-ninth Parallel of latitude. The gardens of the Yukon are one of the horticultural wonders of the world.

Grant the caprice of the seasons; the frost hazard to crops; the irregularity of the precipitation; the strong winds; the shortness of the working season, the harass of mosquitoes and flies; the length and inclemency of the winters; the duration of the winter-feeding period for live stock; the dearth of winter sunshine and its effect upon animal physiology; the well-water problem; the danger of floods and landslides, the transportation handicap; and other difficulties. Allow for the fact that all the production reviewed has been achieved along the shores of a northward-flowing, frost-protective water system, yet the results are still arresting.

Area of Arable Land.

The Mackenzie drainage basin comprises 682,000 square miles of territory, including the valleys of the Liard, Hay, Slave, Peace and Athabaska, the headwaters of the latter reaching south to a point opposite Lacombe in Central Alberta. Part of the Liard, Hay and Slave and the whole of the Mackenzie trunk flow through the sedimentary lowlands of the Mackenzie district. The headwaters drain chiefly the northerly parts of Alberta and British Columbia. The Mackenzie itself lies wholly within the Mackenzie District of the Northwest Territories.

The proportion of arable land in the Northwest Territories is conjectural and the area of reasonably dependable crop land much more so. Guy H. Blanchet, D.L.S., after wide travels across the North, expressed the opinion in 1930 that perhaps 100,000 square miles in the Mackenzie Basin north of the 60th Parallel, which bounds Alberta, might prove available for tillage. Of the land from Simpson north the creek valleys would be found the best. Favoured gardens would be those with a sharp southern slope and subsoil irrigation. Practically all the soils of agricultural value are believed to have been the product of alluvial deposits and water assortment.

There is much muskeg, which according to conclusive proof is capable of successful cultivation wherever drainage is feasible and the frost danger not too great.

Moss peat is an important component of many of the Northern soils. Worked up, oxidized and mixed with mineral particle, it appears to have a beneficial action for a time as a soil ameliorant. After the fibre-destroying process of cultivation has proceeded too far some of these Northern soils become cold and sed, as noted on certain of the older ground at Simpson, Providence, Good Hope and elsewhere. The drained slough at Fort Chipewyan, Alta., on which the Philadelphia Centennial bronze-medal wheat was grown, had been carefully prepared after thorough burning. Later this proved an inferior piece of ground "on account of an excess of clay."

A good deal of the Mackenzie valley seems to have been repeatedly burned, the lightning starting many fires. Fires destroy humus so that much of the area may be expected to represent a rather inferior class of woodland and brule soil. The prevalence of blueberries doubtless denotes acidity. Aridity may be a major explanation of the observed tendency of wild barley to assert itself in abandoned clearings.

In the Mackenzie valley gardening seems relatively more successful than field cropping, probably because the soil requires intensive fertilizing and cultivation, the latter to stimulate biological processes. Under conditions of extended cropping, fertility-maintenance by means of manuring and legumes would doubtless become crucially important.

Climatic Factors.

Summer isotherms in Western Canada sweep northwestward. Throughout a latitudinal spread of 944 miles from Lacombe, Alta., to Good Hope, N.W.T., the July mean temperature is practically uniform. The June mean declines a little toward the North. The May and August means decline more sharply. July is a month of rapid growth.

Calculations made by the author in 1933 showed that as compared with 7.3 inches at Beaverlodge and 6.3 inches at Fort Vermilion, Alta., the four months summer precipitation along the Mackenzie system ran about six inches down to Norman, falling, beyond the Arctic Circle, to four and a half or five inches.

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Evaporation probably moderates towards the North. For a time after clearing the scanty summer precipitation is supplemented by the gradual release of frost-held moisture but when this has been exhausted below the reach of plant roots and capillarity, a modification of dry-farming methods is called for. In the long run the production of a region is limited by its resources of plantfood, sunshine, heat and moisture.

Soil itself is radically modified by vegetative cover and this by climate. Within the soil as it occurs nitrification and other processes are the result of an interaction of heat, air and moisture. In high latitudes the season for these processes is brief. It is rather to be expected that steady cropping would reduce most of the soils to a state of low productivity unless special attention were paid to the application of manure and to rotation with soil-improving legumes. That certain of these legumes, like alfalfa and sweet clover, have shown a measure of promise as far down as Great Slave Lake is more or less reassuring. So is the fact that certain native legumes occur as far north as the Arctic Islands. Perhaps for far Northern agriculture new legumes will have to be found, adapted or bred. We really know all too little about our Northern soils and their scientific utilization. For instance, the extent to which frost-bound subsoil conditions may modify podsolization in forested soils deserves attention. There is much experimenting yet to be done.

Day length and certain salient aspects of micro-climatology have been discussed by the author* at greater length than is here permissible. The long day of high latitudes affects crops variously, according to their established habits. The potato responds favourably to a long day with a low temperature.

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*W.D. Albright, "Crop Growth in High Latitudes", the Geographical Review, Vol. XXIII, No. 4, October, 1933, pp. 608-620.

W.D. Albright, "Climate of the Mackenzie Basin in Relation to Agriculture" (unpublished), World's Grain Conference, Regina, 1933.

Timothy blooms precociously in regions with great day lengths, though, according to Morgan W. Evans,† there appears to be radical difference in the reaction of early and late strains. Irrespective of its specific effects upon vegetative development and inflores-

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†Morgan W. Evans, Associate Agronomist, Division of Forage Crops, Bureau of Plant Industry, U.S. Dept. Agr., Wooster, Ohio. (Memorandum), December 31, 1935.

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cence, the long day intensifies soil processes and plant growth. In July, 1930, fireweed (Epilobium augustifolium) and several species of grasses were as far advanced down the Mackenzie as they were in the Peace a week or two later, the season in the Peace being rather backward that year.

Eleven and a half years' readings at Beaverlodge of self-registering minimum thermometers on a gradual eastern slope with a rise of 134 feet in 214 rods have emphasized the effect of local elevation in warding off summer-night frost and winter low temperatures, the instrument at the foot of the slope having on one occasion read as much as 28° Fah. lower than the one on the hilltop. At the foot there is hardly a month all summer that is free of frost, while on the brow of the hill tomatoes frequently ripen in the open air and roses occasionally bloom until October. Major L.T. Burwash informed the author that he had found still greater spreads between valley and hilltop in the Yukon.

Counteracting the susceptibility of low situations to

Counteracting the susceptibility of low situations to frost is the protective influence of open water, which in summer renders the river valleys safer than neighbouring plateaux, though in winter when the water is ice-bound and the ice covered with snow the canyons may be the colder. Towards the tree line, forest clothes the islands and lines the shores of the streams. This doubtless indicates the ecological factors that will influence crop growth. On the other hand, the ice-cold water of the Arctic seas exercises a retarding influence, hence plant growth is better back from the coast of the Arctic islands.

Nature carpets the boreal forests with moss. Whether man can in the long run increase the net production per acre by clearing the forest and reducing the moss remains to be seen. He can certainly increase insolation. At Hay River (Lat. 60° 52' N.) the permanent frost disappeared from the trench-drained garden surrounded with a clearing. At Simpson (Lat. 61° 52'N.) there is permanent ground frost in the wild but well diggers in 1930 found practically none in the cleared water front. At Thunder River on July 13 frost was found at from six to twelve inches in the mossy forest but at 34 inches in the cultivated garden. At Aklavik on July 11 the measuring stick went down six to eight inches in the forest floor, 12 inches in grass land burned over the first of June and 24 inches in the potato patch. Pulverized, oxidized and mixed with the mineral particle the moss loses much of its insulating character. Solar heat striking the surface may then be absorbed and conducted downwards while at night it may pass upward in sufficient volume to prevent the ground air from cooling below the lethal point. There is strong evidence that clearing and cultivation affect the ground and ground-surface temperatures, which in high latitudes are vital in crop production.

Experienced frontiersmen agree that before any part of the North is opened for agricultural settlement it should be carefully studied and the most likely areas selected. It, then, settlement commences along the water-courses, gradually working back, frost will be fought with the greatest chances of success. Without dispossessing the bison, the reindeer or the muskox it may be possible to introduce poultry and domestic quadrupeds with advantage into some parts of the North, to grow field crops to some extent and gardens almost to the Arctic littoral.

Time tells, The settler conquers, investigators and plant breeders assisting, the latter with earlier and more cold-resistant varieties. Year by year we are rolling back the wilderness towards the Pole, winning for Canadian civilization league after league of productive country--and the end is not yet.